RESEARCH AND DEVELOPMENT TECHNICAL REPORT

DELNV-79-3

LASER DESIGNATOR INTEROPERABILITY TRIALS
(U S Phase Conducted December 1978)

Richard Bulova

NIGHT VISION & ELECTRO-OPTICS LABORATORY

September 1979

ERADCOM

US ARMY ELECTRONICS RESEARCH & DEVELOPMENT COMMAND
FORT MONMOUTH, NEW JERSEY 07703

NOTICES

Disclaimers

The citation of trade names and names of manufacturers in this report is not to be construed as official Government indorsement or approval of commercial products or services referenced herein.

Disposition

Destroy this report when it is no longer needed. D .ot return it to the originator.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DELNV-79-3	2. GOVT ACCESSION NO. AD-A111354	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) LASER DESIGNATOR INTEROPERABILITY TRIALS (US Phase Conducted December 1978)		5. TYPE OF REPORT & PERIOD COVERED Final Technical Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Richard Bulova		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Laser Division ATTN: DELNV-L Fort Belvoir, VA 22060		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PRON NUMBER 21-8-Z0137-01-21-CJ
11. CONTROLLING OFFICE NAME AND ADDRESS Laser Division, Night Vision & Electro-Optics Labs ATTN: DELNV-L-A Fort Belvoir, VA 22060		12. REPORT DATE September 1979 13. NUMBER OF PAGES 21
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release, distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Classified appendices are not included in this report. Agencies desiring classified designator performance data are requested to apply to the Controlling Office.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Target Acquisition	Laser Designators
Laser Acquisition	Target Designators
Laser Rangefinding	Laser Trackers

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Tests of laser designator interoperability were conducted in December 1978. The Army's AN/PAQ-1 Laser Target Designator, AN/TVQ-2 Ground Laser Locator Designator and the British Laser Target Marker-Ranger were determined to be equally capable of designating targets to 5 km for two airborne receivers, Army's AN/AAS-32 and USAF's Pave Penny. Detection by both receivers occurred in excess of 20 km.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

TABLE OF CONTENTS

SUMMARY

Two field tests of Laser Designator interoperability were conducted during December 1978. The three designators - LTD, GLLD and LTM were used to designate targets for acquisition by the ALT, as installed on the AH-1S Cobra helicopter, and by Pave Penny, used on the A-10 Close Air Support fighter. The tests were conducted, respectively, at the Army's Yuma Proving Ground and at the Air Force's Gila Bend Range, both in Arizona. Operations were conducted using various PRF codes, target ranges, types of targets, and aircraft approach angles.

No differences of statistical significance were noted between designators' performances on any parameter tested. Aircraft acquired each designated target with equal efficiency. It can be concluded that the designators are interoperable. Either may be used for missions in support of Cobra or A-10 within the bounds of the tested parameters. An earlier test, conducted during the Spring of 1978 in the United Kingdom (UK), used LTD and LTM to successfully designate targets for tracker equipped British Jaguar and Harrier fighter aircraft. Subsequent to both tests, the tracking accuracy of the LTM was measured by Redstone Arsenal, in addition to quantitative parameters, to determine any limitations to its ability to designate for LGM.

BACKGROUND

With the advent of technology permitting the development of laser guided munitions (LGM) and lightweight, field portable lasers, intensive R&D has been conducted by the US and other nations to field systems using this technology. Perhaps the most notable achievements have been the Hellfire rocket and the 155 mm howitzer-launched Copperhead round. For the first time in warfare, rockets and artillery (formerly effective only against lightly protected area targets) can be steered by means of a laser beam to impact directly on and destroy an armored point target. Other achievements include compact, efficient laser rangefinders (for example, the US AN/GVS-5) and airborne laser trackers (see Glossary). Designators, trackers, and rangefinders can be found separately, or combined, depending upon the intended mission, in both ground and airborne versions. Together these systems provide a means of defense, heretofore unattainable having greater effectiveness in terms of response time, killing power, and savings cost fielding forces.

The United States and the UK, sited side by side in central Europe, have worked cooperatively for years to attain intercompatability between their respective laser guided munitions systems. This intercompatability is now reflected in the requirements of STANAG 3733, applicable to all NATO countries. A scenario has now been developed where either nation can attack a threat target being designated with the other's equipment.

The first phase of demonstrating this compatibility was conducted in the Spring of 1978 when the US Army's LTD and British LTM were used to successfully designate targets for the British Jaguar and Harrier fighter aircraft, on which the Ferranti (UK) LRMTS had been installed. Details are available to qualified agencies upon request.*

INTRODUCTION

This test report covers the second and final phase of inter-compatibility testing. LTD, LTM and GLLD were employed to designate for two US aircraft currently available with laser receivers. The two aircraft are the Army's AH-1S Cobra (TOW) attack helicopter, equipped with the ALT and the Air Force's A-10 close air support fighter, equipped with Pave Penny. In addition, the capabilities of the LTM and GLLD to designate directly for precision guided munitions such as Copperhead or Hellfire were also measured. In operations of this latter kind, visual target acquisition by the weapon's gunner is not required, unlike the AH-1S or A10, since the round automatically steers itself in flight towards the laser illuminated target. Some directional information is still needed, however, to fire the round within its launch envelope. ** Generally, the smaller LTD is not considered for such (LGM) applications since designator requirements (e.g. beam divergence, power, tracking accuracy) become more stringent.

TEST PLAN AND RESULTS

US tests were conducted at three locations: Yuma Proving Ground, AZ; Davis-Monthan Air Force Base, AZ; and Redstone Arsenal, AL.

Yuma Proving Ground (28-29 Nov 1978):

The designators were sited together on North Cibola range to lase on command at three 4' x 8' panels having a 10% reflectivity and at ranges of 1.5, 3.4, and 5.2 kilometers. The ALT equipped AH-1S helicopter would fly away from the targets to a distance of approximately 25 kilometers, a designator would be turned on and the aircraft would fly in towards the target area until ALT lock-on occurred. Both high and low PRF codes were

---

* Applications should be sent to Procurement Executive, Ministry of Defense, ATTN: AS SIP 2 (Major J.A.E. Hawxwell), Room 342 Fleetbank House, 2-6 Salisbury Square, London SC4Y 8AT. The report's title is "US/UK Laser Interoperability Trials, 22 May through 2 June 1978," and is classified CONFIDENTIAL.

**Provided for Copperhead by the Artillery Fire Direction Center and for air-to-ground laser guided missiles by wide area scanning trackers (e.g. TADS on the Hellfire-armed AAH).

used, and occasionally, each designator was directed to temporarily set his PRF code one step off, or at a harmonic of the code set on the ALT receiver. Approaches were made by the aircraft both in line with the designator-target azimuth and at a 45° angle. Together, this test plan generated a 36-cell matrix of designators (three), target range (three), designator-target-aircraft aspect angle (two), and PRF coding (two). Aircraft altitudes were distributed from 3000' to 7000' during the 36 test runs. Weather was clear during the test duration, with generally unlimited visibility.

The ALT locked-on satisfactorily to the designated target through the test matrix. Lock-on occurred most often at the beginning of the aircraft fly-in at an average range of 25 kilometers. In all instances, lock-on occurred at ranges in excess of 20 kilometers. No differences in performance between the three designators could be noted throughout the test. Bar charts plotting the combinations of variables against aircraft range to the target at time of acquisition may be seen in Figure 1. Similarly, no distinction was seen in acquisition range versus Pulse Repetition Frequency (PRF) code used. No ALT locked-on occurred when false PRF coding was used. Because of the geographic restrictions associated with the North Cibola Test Range, no attempt was made to determine the maximum detection distance for the designators by the ALT. There were no equipment failures. A more detailed report, prepared by test and evaluation personnel at Yuma Proving Ground, is attached as an Appendix.

Davis Monthan AFB (30 Nov - 1 Dec 78):

This test determined intercompatibility between the Air Force's Pave Penny system as installed on A10 and the three designators. The designators were positioned together using a scrap truck and bus approximately 2 km downrange as targets. Two A10's participated, flying together, and the distance from the target at time of Pave Penny acquisition was recorded by each fighter. Eighteen fly-ins were made by each. High and low PRF codes were tried, and aircraft altitudes were varied from 100' to 5000'. Designator-target aircraft aspect angle was about 40°. The A10's flew away from the target approximately 30 km before turn-in for each run. The weather, as at Yuma, was clear with the exception of a light, low lying mist.

At the 500' approach altitude, where line-of-sight to the target area was possible, detection and lock-on occurred at almost 30 kilometers for the GLLD, and at only slightly lower distances for the LTD and LTM. As the aircraft began runs at lower altitudes (under 4000'), intervening terrain masked the target area initially, but once cleared, Pave Penny lock-on occurred almost instantaneously for each designator. Three runs (Trial No. 6) made at 100' altitude were at an aspect angle of 110°. In this case, all designators were successful in obtaining Pave Penny lock-on by illuminating the edge of the target on the

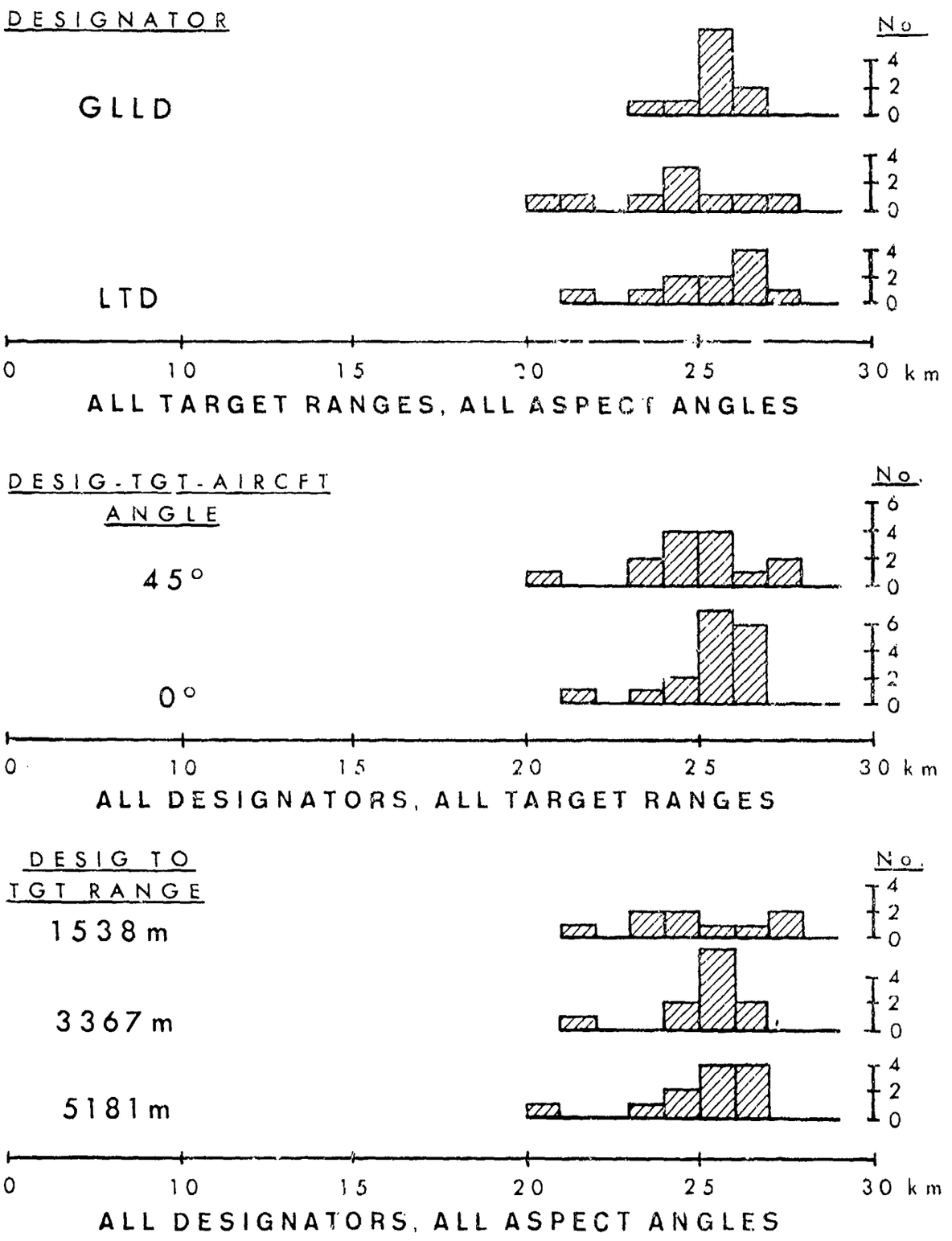

Figure 1. Aircraft range to target at acquisition, YPG.

side towards the aircraft's approach. Following the last formal run-in, the A-10's made a short turn-in (Trial No. 7) for a bombing run, using the tracker marker generated on their Heads-Up Display (HUD) by Pave Penny to provide release information. The bombs impacted on target. Data from these runs are shown in Figure 2. As with the Yuma trials, flight test plan and geographical constraints precluded the measurement of maximum detection range. The acquisition ranges shown in this report must, therefore, not be construed as representing the maximum capabilities of either the designators or the trackers since, as already mentioned, acquisition generally coincided with aircraft turn-in.

DISCUSSION

This Interoperability Trial was not a test of laser guided munitions themselves or aircraft fire control systems since, with few exceptions, no ordnance was released by the tracker-equipped aircraft. The exceptions, as in the one A10 bombing run and the Phase 1 UK. fighter tests, were performed as side tests. While ordnance release passes were performed and were successful, the system details are beyond the scope of this report. Generally, it may be said that the aircraft installed tracker presented a marker indicating the target location on the pilot's Heads-Up Display. When aligned with a second marker generated by on-board fire control computers showing ordnance impact location at that moment in time, release would be indicated.

As a side test during the YPG trials, the Cobra was flown in towards the target several times, guided by the location displayed on the pilot's HUD by the ALT until the target could be visually observed by the gunner through his 13x magnification TOW sight which also was being held on target by the ALT. In all instances, the target, when it appeared, was well centered in the sight and readily permitted hand-off from ALT to the gunner for manual control of the TOW missile if launched.

Tracking accuracy was measured on the designators at Redstone Arsenal, AL in Dec 1978. This parameter represents the ability of the operator-designator/mount to hold the laser beam on a moving target with sufficient tolerance so as to not degrade the LGM's probability of a hit. That probability is characterized by the LGM's Circular Error Probability or CEP, which is the diameter of the circle around the designated point in which 90% of the rounds would impact. Any lost capability by the operator in holding the laser on the target causes an increase in CEP and subsequent reduction in kill probability. Tracking accuracy has been characterized for the GLLD and the LTM. Results are classified CONFIDENTIAL but may be obtained on request from the Monitoring Agency specified on the DD Form 1473. As briefly mentioned earlier in this report, the hand-held LTD is normally not considered as a candidate designator for LGMs, because of the

Trial No.	PRF Code	Desig.	Target Acquisition Range (naut. mi.)* A-10 #1	#2	A/C ALT (ft)	A/C-tgt-des.angle
1.	687	LTD	10	13	5000	39
		LTM	11	14		
		GLLD	14	16		
2.	112	LTD	--	--	3000	39
		LTM	12	11		
		GLLD	12	13		
3.	686	LTD	8	7	1000	39
		LTM	6	5		
		GLLD	9	8		
4.	113	LTD	7	5	500	34
		LTM	6	5		
		GLLD	5	6		
5.	685	LTD	6	6	200	34
		LTM	6	6		
		GLLD	6	5		
6.	114	LTD	4	4	100	131
		LTM	4	4		
		GLLD	4	4		
7.	684		Immediate (short turn-in)		1000	45

* 1 Nautical Mile = 1.852 kilometers

Figure 2. Gila bend data.

inherent difficulty in tracking a moving target with a hand-held device. The LTD's lower output power and larger beam divergence also contribute to this inability to provide more than a pointer for more accurate control means such as the AH-1S's stabilized TOW sight. At short (< 1 km) designator-target ranges, the LTD may still, however, be a reasonable field expedient for LGM designation and should not be discounted under such circumstances.

Command, Control, and Communications (C^3) between the designator operator and the aircraft varied considerably during these trials. There is presently no formal doctrine within the US Army, therefore, a brief discussion is felt warranted here.

a. UK: In the British tests using RAF fighters, a mission request from the Artillery Forward Observer (FO) or the designator operator would be transmitted to the Fire Support Coordinator (FSCOORD) at Battalion or Brigade level. Coordination with the attached RAF Forward Air Controller (FAC) would vector the fighter aircraft to the target area where direct air-to-ground communications would be established with the FO.

b. US Army: At Yuma, a control helicopter (UH-1H) coordinated the FOs with the AH-1S attack helicopter, providing the TOW gunner with proper PRF coding, target description, and target azimuth. When the AH-1S indicated a ready condition, the control helicopter would contact the FO who would then begin lasing. Target detection, when announced by the TOW gunner, would be relayed by control to the FO who would then cease designating. Alternatively, once the AH-1S indicated ready, communications would then be directed between the FO and attack helicopter, with the control ship monitoring.

c. US Air Force: At Gila Bend the FAC was colocated with the designators and would verbally command their operation while in radio contact with the A-10 fighters. USAF is currently planning to provide some FAC's with the LTD for personal use in directing close air support missions by Pave Penny/Pave Spike - equipped aircraft. This coincides with current USAF doctrine where the FAC visually observes the intended target area from a position near the Forward Edge of the Battle Area (FEBA).

During operations at Yuma, target masking by the AH-1S's cockpit canopy occurred when the line-of-sight from the target to the ALT receiver coincided with the helicopter's direction of flight, and the depression angle exceeded 12 degrees. This occurred only during high altitude fly-ins at 7000', and is not considered a shortcoming since tactical employment of the AH-1S is normally at or near tree-top levels.

Several trials were performed at Yuma where the designator was coded incorrectly. Codes used were one number higher and lower than the ALT code. Codes which were exact harmonics of the correct code were also tried. In no case did ALT detect the incorrect codes.

CONCLUSION

1. During the course of all Interoperability Trials, the following matrix of laser designator-receiver combinations were evaluated:

Designators	ALT	RECEIVERS LRMTS	PAVE PENNY
LTD	X	X	X
LTM	X	X	X
GLLD	X	-*	X

All combinations worked satisfactorily, and it has been shown that at designator-to-target ranges out to 5 km and target-to-receiver ranges out to 20 km, performance was indistinguishable during the US tests.

2. LTM and GLLD have been demonstrated to be capable for use in designating for Laser Guided Munitions. While the maximum range for which LTM may be used without adversely affecting the munition's hit probability is somewhat less than for GLLD, this is not considered a deficiency. Intervisibility distances normally encountered in the field between ground observers and targets are, with high probability, less than the effective range of both systems. In addition, on those occasions where exceptional line-of-sight distances occur, the integral rangefinding capabilities of both LTM and GLLD will inform the operator when designation should not be attempted.

3. Doctrinal procedures for Command, Control and Communications (C^3) between the designator and gunner have not been finalized, and remain to be addressed by US Army prior to fielding these systems to determine the most effective method.

---

* GLLD not available during UK trials.

APPENDIX [1]

AIRBORNE LASER TRACKER (ALT) TEST
(Performed in conjunction with Critical Issues Demonstration)

1. OBJECTIVES

a. To determine if the integration of the ALT with the Enhanced Cobra Armament Program (ECAP) subsystems, specifically the TOW Missile Subsystem (TOW), is complete.

b. To determine if the US laser target designator (LTD) and ground laser locator designator (GLLD) can be used interoperably with the British laser target marker (LTM) when used in conjunction with the US ALT.

2. CRITERIA

None

3. DATA ACQUISITION PROCEDURE

The series of tests performed during these trials was basically that of operating the various laser designators on targets at varying ranges and verifying that the ALT acquires, locks-on, and tracks the designated target.

The three designators used for these tests were the LTD, GLLD, and the British LTM. The laser tracker used was the US ALT which was mounted on the sail of the AH-1S Modernized Cobra with Fire Control Subsystem.

The series of runs listed in Table 1 were performed as listed in chronological order. The test aircraft performed identical runs for each designator to detect any difference in acquisition range. The three targets used were 4' by 8' plywood sheets painted olive drab (approximately 10 percent lambertian reflective) and were located at 1538, 3367, and 5181 meters from the position of the laser designator. Because of the topography of the test range, aircraft altitudes, ranges, and run in angles were limited. Run in or aspect angles of the aircraft attempted were 0 degrees and 45 degrees from the designator to target line-of-sight. Actual target acquisition ranges were determined by the AN/ASN-128 Doppler Navigation System on-board the test aircraft and confirmed by the chase aircraft by reference to topographic landmarks.

Checks were made by cycling the designators on-off-on to ensure acquisition, break-lock, and reacquisition. False or nonmatching codes were used occasionally to validate results.

---

1. Excerpt from YPG Report 368, Development Test II (PQT-G) of Enhanced Cobra Armament Program (ECAP), Fire Control Critical Issues Demonstration, Final Letter Report by John Sanborn, March 1979, US Army Yuma Proving Ground, Yuma, Arizona

TABLE 1. ALT - LASER DESIGNATOR - INTEROPERABILITY AND INTEGRATION TEST CONDITIONS.

TEST CONDITIONS							TEST RESULTS	
Run No.	Designator* No.	Code	Designator to Target Range (m)	Aspect Angle Aircraft to Target (°)	Aircraft Course (deg magnetic)	Alt** Scan Mode	Aircraft Range to Target at Acquisition (km)	Aircraft Flight Altitude (ft)
1	1	687	5181	0	263	Scan 2	26.0	4300
2	2	687						4300
3	3	687						4300
4	1	112					26.0	4000
5	2	112					25.2	4000
6	3	112		0	263		25.6	4000
7	1	686		45	218		24.5	3000
8	2	686					24.0	
9	3	686					25.0	
10	1	113					23.0	
11	2	113					20.5	
12	3	113	5181	45	218	Scan 2	25.0	3000
13	1	685	3367	0	242	Scan 1	25.3	6700
14	2	685					25.5	
15	3	685					26.0	
16	1	114					26.2	
17	2	114					25.5	
18	3	114		0	242		25.7	
19	1	684		45	197		25.8	
20	2	684					24.8	
21	3	684					25.5	6700
22	1	115				Scan 1	21.0	7000
23	2	115				Scan 2	14.0	7000
24	3	115	3367	45	197		24.2	5000
25	1	683	1538	0	295		24.2	3500
26	2	683					24.6	
27	3	683					23.5	
28	1	116					No data	
29	2	116					21.0	
30	3	116		0	275		25.0	2500

TABLE 1. ALT - LASER DESIGNATOR - INTEROPERABILITY AND INTEGRATION TEST CONDITIONS (Contd).

TEST CONDITIONS							TEST RESULTS	
Run No.	Designator* No.	Code	Designator to Target Range (m)	Aspect Angle Aircraft to Target (°)	Aircraft Course (deg magnetic)	Alt** Scan Mode	Aircraft Range to Target at Acquisition (km)	Aircraft Flight Altitude (ft)
31	1	682	1538	45	230	Scan 2	27.0	3700
32	2	682					27.0	
33	3	682					No data	
34	1	117					26.0	
35	2	117					23.0	
36	3	117	1538	45	230	Scan 2	27.0	3700

*1 = LTD (Laser Target Designator
2 = LTM (Laser Target Marker
3 = GLLD (Ground Laser Locator Designator)

**Scan 2: Wide Field
Scan 1: Narrow Field

Verification of ALT acquisition and lock-on to the designated target was made by switching the aircraft systems to the ALT acquisition mode in which the ALT slaves the Telescopic Sight Unit (TSU) and Heads-Up Display (HUD) pointer to the target. Acquisition was accomplished at ranges that far exceed the optical sighting capability of the 13-power TSU; therefore, to verify the slaving accuracy on selected runs, the aircraft was flown in towards the target, tracking the ALT angular direction until the target was visible in the TSU field of view. At that point, a determination of the ALT angular error in TSU slaving could be made.

The test aircraft was flown by a Bell Helicopter Textron (BHT) test pilot with a BHT flight test engineer in the front seat. The various laser designators were operated by the following personnel:

(a) LTD - YPG aircraft armament gunners,

(b) LTM - British military officers,

(c) GLLD - YPG aircraft armament gunners and Hughes Aircraft Co. (HAC) representatives,

British participation was requested to facilitate testing of US/UK laser designator interoperability.

4. RESULTS

The ALT acquisition ranges with the associated aircraft altitudes are listed in Table 1. Data were not obtained on test runs No. 28 and 33 due to low designator batteries. These runs were not repeated due to the brevity of the test period and were deemed nonessential in addressing the objectives and criteria of the test.

The acquisition range of test run No. 23 was shorter than the ranges of complimentary runs 22 and 24 because the topography of the range interfered with acquisition. The ALT scan mode was changed to "2" part way through the run and the run was not repeated.

The acquisition ranges shown in Table 1 do not represent the actual maximum range that the ALT could track. These figures were the maximum ranges that the aircraft could be flown to because of topographic restraints.

On test runs No. 6, 12, 18, and 24 the aircraft was flown to the designated targets so that the co-pilot/gunner could view the sight picture of the TSU and determine to what degree the TSU is slaved to the ALT. On run #6, the target being designated appeared directly in the center of the sight picture (0 degree aspect angle). The sight picture on run #12 showed the target to be approximately 2 mils low, moving to zero as the aircraft approached the target (45 degrees aspect angle).

GLOSSARY

ALT - Airborne Laser Tracker AN/AAS-32. A US Army laser receiver mounted on the sail of the AH-1S Cobra (TOW) Attack Helicopter. The ALT scans for and locks onto properly coded designated targets, and provides pointing information to the aircraft's fire control system. Rangefinding capabilities are not integral but are instead provided by the TOW sight.

GLLD - Ground Laser Locator Designator AN/TVQ-2. A US, tripod mounced designator, also with rangefinding capabilities. It weighs 51 lbs and has the highest output power and narrowest beam of the three designators. A thermal night sight, similar to that used by TOW, has been developed for attachment, providing operational capabilities during periods of limited visibility. It has the capability of designating and tracking, if needed, point targets for Laser Guided Munitions (LGM).

LGM - Laser Guided Munitions. A term used to describe a munition's capability to "see" a laser-illuminated target by means of an installed electro-optical receiver, and to automatically steer itself with controllable vanes towards the illuminated spot. Typical examples are the Hellfire missile, launched from attack helicopters, and Copperhead, an artillery round, fired from 155 mm Howitzers.

LRMTS - Laser Ranger and Marked Target Seeker. UK version of ALT, it also incorporates a built-in laser rangefinder. It is presently installed on Jaguar XX109 and Harrier XV742 fighter aircraft, and is planned for use on British attack helicopters carrying the US TOW Missile.

LTD - Laser Target Designator AN/PAQ-1. A lightweight (16 lbs) shoulder operated US designator.

LTM - Laser Target Marker-Ranger. A British tripod-mounted designator with rangefinding capability. Its weight and performance is greater than the LTD, but slightly less than the GLLD.

Pave Penny - US Air Force version of ALT. It is mounted below the nose of the A-10 close air support fighter. While not interchangeable, the two receivers have similar capabilities.

PRF - Pulse Repetition Frequency. The means used to code all laser designator and receivers to permit discrimination between simultaneously illuminated targets by the attacking aircraft.

On Run No. 18,
the target appeared 1 mil high and 1 mil right (0° aspect angle) while on run No. 24 the target was 3 mils right and 1 mil low in the sight picture. These readings were at an approximate aircraft-to-target range of 3000 meters and closed to zero as the aircraft approached the target. The primary reticle reference marks in the TSU are ±5 mils from the center so that acquisition drive to within 5 mils would result in instant visual target detection by the AH-1S gunner if he is within optical detection range.

During run No. 34, the LTD was set at the false code of 116 (instead of 117). The aircraft never acquired the designated target which was expected. The run was repeated with the proper code of 117 and was successfully completed.

After the ALT had acquired and locked on to the target during each of runs No. 25, 26, and 27, the designator used was shut off-on-off and then the next designator in line was turned on. The ALT, in each case, broke lock, reacquired, broke lock again, and then reacquired the new designated spot.

5. Analysis

The very high accuracy of ALT-TSU slaving, freedom from noise effects, successful break-lock and reacquire, successful code detection, and ease of operation verified successful integration of the ALT to the AH-1S Modernized Cobra.

No differences in acquisition range, sensitivity to aspect angle, or laser coding were detected between the three laser designators, the LTD, LTM, and GLLD. They are therefore considered to be interoperable.